FIRE II Cirrus
Mission Summary

Date: December 4, 1991
Julian Day: 338
Experiment Day: 22

Summary | Active Sensors | Passive Sensors | Sonde and Sfcmet

Mission Scientist: David Starr
Deputy Mission Scientist: Eric Smith

Mission Objective:

Cloud Microphysics and Remote Sensing

Mission Description:

In situ microphysical, thermodynamic and dynamic profiling of a cirrus cloud band in close coordination with ground-based remote sensors at the Hub site. All lidars participated in the mission - our best multiple lidar mission to date.

Also, the Sabreliner sampled upper tropospheric water vapor field along its route back from south Texas for possible comparison to concurrent GOES/VAS observations. The planned second day of the Gulf mission was cancelled due to lack of clouds.

Weather Synopsis:

Crystal clear, calm and cold conditions prevail in Coffeyville for most of the day. Morning temperatures were in the low 20's. The wave patterns attributed to the Mt. Pinitubo aerosol layer were again visible around sunrise. A few cirrus were seen in the morning. In the late afternoon, scattered cirrus were visible in the northwest sky, mostly spissatus and contrails. During the evening hours, a long thin band of cirrus extended from NE New Mexico along the southern border of Kansas and into Coffeyville. Later, additional generation occurred near Coffeyville and around the northeastern Oklahoma-Kansas border. Remote sensors showed development at multiple levels and layer interaction within this simple-appearing system from satellite. The brightest stars were visible during most of this episode.

Synoptic Situation:

The deep trough that passed the previous day continued to move eastward toward the Appalachians and the following large scale ridge flattened out considerably over the west. Extensive mountain wave clouds were observed along the Rockies from Wyoming into Canada in association with an extensive ridge-crest cirrus system that moved eastward into the upper Great Plains during the day. Cirrus from this system made it into northern Kansas. At the same time, the cyclone-appearing upper tropospheric cirrus generating system off the Baja re-intensified and the upper level outflow began to penetrate further north into Arizona and New Mexico. Mountain wave clouds began to develop in New Mexico and streamed downstream in the westerly flow. It was such a band, originally generated in NE New Mexico, that was sampled over Coffeyville. However, it was fairly clear that this was not simply a long mountain wave cloud given the development that was observed.

Aircraft	Depart	Land	Notes
NASA ER-2			No flights
NCAR King Air			No flights
NCAR Sabreliner			Transit flight back from Corpus Christie, potentially good water vapor/VAS mission
UND Citation	00:12 CST	02:49 CST	Excellent nighttime mission over the Hub. Pilot saw Univ. Utah laser beam in cloud!

Satellite	Hub Overpass Time	Zenith Angle	Azimuth Angle	RAOB
NOAA-11	21:19:53	35.91	259.47	yes
	09:44:17	11.45	104.35	yes
NOAA-12	13:57:06	38.07	100.54	yes
	01:17:00	19.92	72.88	yes

Rawinsonde Operations:

- Inner NWS stations (Type A): Enhanced mode @ 12, 18, and 00 UTC
- Outer NWS stations (Type B): Routine mode @ 12 and 00 UTC
- Hub CLASS station: Enhanced mode @ 12, 18, 00 and 06 UTC, plus
  - satellite overpasses @ 14, 21, 01 and 10 UTC
  - and an extra at 19 UTC.
- Remote CLASS stations: Enhanced mode @ 12, 18, 00, and 06 UTC
  - (plus 12 UTC on 12/5)
- Hub GSFC/WFF station: Launches @ 18, 22, 23, 02, 05 and 08 UTC
- CSU Parsons station: Launches @ 17, 20, 22, and 04 UTC

FIRE Profiler Status:

- CSU 405 MHz @ Parsons: Continuous operation (RASS: 15-23 UTC)
- PSU 50 MHz @ Coffeyville: Continuous operation with RASS
- NOAA 405 MHz @ Coffeyville: Not operational

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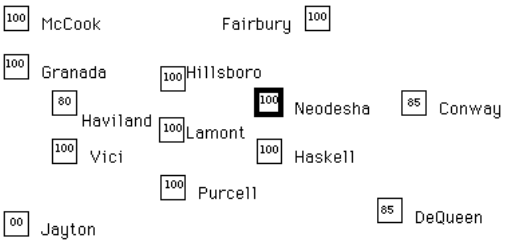
NWS Wind Profiler Status:



SPECTRE Operations:

Full up operations captured another excellent clear sky case as well as the thin cirrus case during the evening.

Aircrew/Mission Scientist Debrief Notes:

- PROLOG: The planned ER-2, Sabreliner, LANDSAT mission over the Gulf of Mexico was cancelled due to the lack of clouds and the expectation of good conditions over the Hub later in the day. The Sabreliner flew back to Coffeyville from Corpus Christie at an altitude of 10 km with its instruments and data systems operating. The transit flight may satisfy our requirement for a large-scale upper tropospheric water vapor gradient mission in conjunction with GOES/VAS.
- GENERAL, A.M.: A dissipating cloud band that was part of the ridge-crest cirrus system over the northern Great Plains and Rockies was observed in the morning at Parsons between 0730 and 0900 CST at altitudes between 10 and 12 km. Although visually sighted, this cloud feature never actually came over the Hub. The Mt. Pinitubu aerosol cloud was observed between 23 and 26 km.
- GENERAL, P.M.: Sporadic observations of a thin cirrus cloud or contrails were made during the mid-afternoon at altitudes from above 12 km to 13 km. By about 0100 UTC (well after sunset), reports of a thin wispy cirrus layer at 11 km began to come in. By about 0400 UTC, cirrus were being observed by all the lidar systems between about 10 and 13 km. All lidar systems were now running at full bore. Data from the VIL system were being pumped into the operations center and showed a complex and evolving system. The cirrus were part of a long east-west oriented cloud band that lay directly over the Hub. The main band appeared to be about 60 km wide but an even greater width was apparent at the highest level in the VIL imagery. Cloud base lowered to around 8.5 km by 0600 UTC at which time the Citation took off. VIL imagery showed that cloud base was associated with a distinct second cloud layer that sloped downward in the downstream direction (to the west). The upper cloud layer appeared to develop downward via a precipitation process as fall streaks were very evident. Strong interactions were apparent between the layers.
- UND CITATION: A step-up flight pattern was flown in 1K' increments from 28 to 40K' using fairly short flight legs (~15 km). Temperature was -64deg.C at 40 K' (12.2 km). Crystal concentrations varied from 0-80 per liter at 31 K' with fairly large crystals. At higher altitudes, concentrations and sizes were substantially less (10-30 per liter at 37K' and 3-5 per liter at 39K'). It was an interesting experience seeing the real-time VIL images and conversing with the Citation crew during the mission. There was no moonlight and the cirrus were optically thin (stars remained visible throughout the night). After sampling the lower levels and then encountering a region of very sparse crystals, they needed great assurance that there was actually more good cirrus above. The coincidence of their observations of crystal concentration at various altitudes and the VIL images was truly impressive. At the time they were sampling the 40K' level, a panic of reports came in from various lidar groups about a very hard layer at 9-9.5 km where specular reflection and extreme attenuation was occurring. The Citation commenced a spiral descent at 1K' per min. to 28K' to investigate. The base was found at 27.8K' and the top at 31K'. Legs were flown at 29, 30 and 29K'. Temperature was -38deg.C at 29K'. Crystal concentrations (2D-C) ranged from 20-100 per liter and then up to 197 per liter. These were by far the highest values encountered in true cirrus during the entire experiment. Coordination with the surface-based sensing systems was perfect as the Citation pilot reported actually sighting the "green beam" of the Utah lidar system off his left wing-tip during an overpass.

Significant Hardware Problems:

- None other than continuing RASS problems.

Highlights of FIRE Operations:

- Obtained the required large-scale upper tropospheric water vapor case (*in situ* vs GOES/VAS).
- Both an excellent clear sky and thin cirrus case for SPECTRE.
- Very successful interactive coordination of aircraft and active remote sensors on the ground.
- Absolutely the best lidar observations yet. Just about idea conditions with all systems operating.
- Obtained excellent *in situ* and remote sensing observations along with rawinsonde and profiler data sets adequate to define the dynamical environment. This should be a great case!
- Sampled a very pristine lower cirrus cloud layer with rather remarkable effects on the remote sensing systems and the highest concentrations of ice crystals to date..

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Instrument Logs

Active Sensors

Active Sensor	UTC Hour																								Notes
	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	
Utah Lidar H															X	X	X	X	X	X	X	X			
LaRC Laser Ceilometer H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Wisc HSR Lidar H													X	X	X	X	X	X	X	X	X	X	X	X	
Wisc Vol Image Lidar					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
GSFC RAMAN Lidar H													X	X	X	X	X	X	X	X	X	X	X	X	
NOAA CO2 Lidar H			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
NOAA Radar H																									NOT OPERATIONAL

PSU Radar H			X	X	X										X	X	X	X	X	X	X		
PSU Laser Ceilometer H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PSU 50 MHZ Wind Prof H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PSU/NOAA 50 MHz RASS H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
NOAA 405 MHz RASS H																								NOT OPERATIONAL
LaRC Lidar P			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CSU Wind Prof/RASS P	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	RASS FROM 15 TO 23 UTC
CSU Laser Ceilometer P	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

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Passive Sensors

Passive Sensor	UTC Hour																							Notes
	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	
NOAA μ-wave Radiometer H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
NOAA Sun Photometer H					X	X			X	X															
NOAA H20 Photometer	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
NOAA IR Flux Radiom. H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
NOAA Dobson Ozone H				X			X																		
NOAA Surface Ozone H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
NOAA Trace Gas H						CF				CF															
PSU μ-wave Radiometer H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	POSSIBLE OSCILLATIONS AFTER 19 UTC
PSU Sun Photometer H																									NO OBSERVATIONS
PSU Solar Flux Radiom. H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PSU IR Flux Radiometers H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PSU Sky Video H																									NO OBSERVATIONS
Utah IR-Window Radiom. H															X	X	X	X	X	X	X	X			
Utah Sky Video H				X	X	X	X	X	X	X	X	X													
LaRC Video H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
AFGL Sky Imager H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Ames Radiometer H	X	X	X	X	X	X	X	X	X	X	X	X													
Denver Solar Radiom. H							X				X														
Denver IR-Spectrometers H						X	X	X	X	X	X			X	X	X	X	X							
GSFC IR-Spectrometer H								X	X	X	X				X	X	X	X	X	X	X				
Wisc. IR-Spectrometer H						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
MRI Sun Photometer H			X	X	X	X	X	X	X	X	X														
MRI IR Radiometer H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
MRI Spectro-Radiom. H							X	X																	
MRI Solar Flux Radiom. H	X	X	X	X	X	X	X	X	X	X	X	X													
GSFC Sun Photometer H	X	X	X	X	X	X	X	X	X	X	X	X													*NOT VERIFIED
CSU Sun Photometer P		X	X	X	X	X	X	X	X	X	X	X													
CSU IR-Window Radiom. P				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CSU Solar Flux Radiom. P		X	X	X	X	X	X	X	X	X	X	X													
CSU IR Flux Radiometers P	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CSU IR-Spectrometer P				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CSU Sky Video P				X	X	X	X	X	X	X	X	X													
Ames Spectroradiometer H	X	X	X	X	X	X	X	X	X	X	X	X													
Ames 10 μm narrow fov H	X	X	X	X	X	X	X	X	X	X	X	X													
CISRO/WPL/PSU IR W. Rad							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

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Sonde and Surface Meterology

Sonde + Sfc Met Sensor	UTC Hour																							Notes
	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	
NOAA Ozone Sonde H																X									
WFF Sonde H							X			X		X			X			X			X				
NCAR Cloud Ice Sonde H																									NO LAUNCH
NCAR/CLASS Sonde H	X		X				X	X		X			X	X					X				X		SOME WIND DATA LOSS
NCAR PAMS H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
NCAR/CLASS (remote)	X						X						X						X						SOME WIND DATA LOSS
NCAR PAMS (remote)							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	IOLA, ARKANSAS CITY DOWN, MUSKOGEE UP @ 18 UTC

CSU Sonde P						X			X		X						X							
CSU Sfc Meteor. P	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Type A NWS Sondes	X						X						X						X					NOTE SPECIALS AT 06
Type B NWS Sondes	X												X											
PSU Sfc Meteor H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	